Fourier Analysis - 25242 - MATH 362 - 001 **Fall 2017 Wubben 112**

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Office Hours: 10-10:50 am MW; 9:25 – 10:50 am TR. Appointments also available (24 hours advanced notice recommended).

Text: *Elementary Fourier Analysis with Audio and Image Processing,* Phil Gustafson

Course Description: This course provides an introduction to Fourier methods in signal processing. Particular emphasis is given to signal expansions and Fourier coefficients. Calculus is used to understand how signals can be analyzed in the continuous time setting, while matrix and vector arithmetic will play a prominent role in the discrete setting. Applications will also be examined, including frequency filtering, JPEG compression, and MP3 compression. A complete listing of course topics is given on the course calendar below.

Student Learning Objectives: The student learning outcomes for this course are to develop the following:
- Independent learning skills, in particular, reading skills
- Problem-solving skills
- Mathematical language skills
- Persistence, skill in exploration, conjecture, generalization
- Appreciate necessity for rigor and precision in mathematics
- Develop skills to implement and use technology, and to understand its limitations
- Acquire mathematics background relevant to other subjects
- Develop a broad general understanding of mathematics
- Develop facility with recording and analyzing sound waves; loading audio and image files onto the computer; using computer software such as MATLAB, and Word

Prerequisite: A grade of C or better in Math 152.

Required: Access to a computer with a word processor (typically Word), internet, microphone, and MATLAB.

Grading: The following categories determine your grade:
- Attendance…….……....3%
- Class Prep…… 11%
- Homework…..…….. 11%
- Quizzes……..……. 40%
- Final Project…….. 30%
- Total……...…… 100%

Grading Scale:
- 90 - 100 %…….. A
- 80 - 89%…….. B
- 70 - 79%…….. C
- 60 - 69%…….. D
- 0 - 59%…… F

Credit Hours Policy: An undergraduate student should expect to spend on this course a minimum of two hours outside of the classroom for every hour in the classroom; see the CMU *Curriculum Policies and Procedures Manual*.

Attendance: Attendance will be taken daily and converted into a percentage at the end of the semester. Coming late is better than not coming at all; however, frequent late arrivals will not earn points towards the attendance grade. See Attendance, Course Participation, and Academic Behavior paragraphs on the next page for further information on the role of attendance and class conduct in this course.

Class Prep: To help develop your independent learning skills, you will be reading ahead in the book each week and turning in a class prep for the scheduled sections that week. The class prep will incorporate the MATLAB commands from the reading as well as the key concepts for that section. Each class prep will be written up using Word and submitted as a pdf file to D2L. Additional information on class preps will be given in class.

Written Homework: Written homework will be graded on accuracy, completeness, neatness, and adherence to the following requirements. Additional expectations regarding homework will be discussed in class.
- Each homework assignment will be written up using Word and submitted as a pdf file to D2L. Occasionally you will need to use Word's equation editor to format the answers. If you haven't dealt with formatting text, equations, and graphs in Word, then this will be an important skill for you to develop.
- The beginning of each section must be clearly labeled and begin on a new page. The beginning of each section must include a list of the assigned problems for that section
- All homework problems must be numbered, worked in order and must be legible.
- Each homework packet is submitted on time.

Quizzes: There will be nine regular semester quizzes. The lowest two quiz scores will be dropped (instead of make-ups). The quiz dates are listed on the course calendar given below. These quiz dates occur during our regularly scheduled class time and you are expected to attend. Work, travel, vacation or any other non-college sanctioned activity is not an acceptable excuse for missing a quiz.

Final Project: The final project will be a comprehensive project involving techniques developed throughout the semester, and will include a typewritten component and a presentation component. See course calendar for deadlines related to the final project. Further information regarding the final project will be given in class.

Final Exam: This time slot will be used for final project presentations, and all students are expected to attend during this college-scheduled time. See course calendar.

Cell Phone Policy: At the beginning of class cell phones (and all other portable technology devices) must be silenced and put away out of reach, such as in a backpack rather than placed in a clothing pocket. In-class image and video capture is not allowed except in unusual circumstances and permission must be obtained in advance. A few friendly reminders to put your phone away may be granted early in the semester, but for persistent violators each observed unapproved instance of a cell phone or technology violation will result in a 1 point deduction from their semester total (see Course Participation below), with additional consequences possible (see Academic Behavior below). Furthermore, during quizzes and exams, cell phone violations will be interpreted as acts of academic dishonesty.

Attendance: Daily attendance in class is crucial for your learning in this course. If you miss class, it is your responsibility to make up what was covered. I may follow the statement on attendance in the Maverick Guide, as part of the CMU Student Code of Conduct found online, which enables the instructor to initiate a drop or withdrawal for any student who fails to attend regularly. Read this attendance statement in your catalog carefully.

Course Participation: Course participation includes coming to class a few minutes early, being prepared for class, asking questions, participating in discussions and activities, and seeking help outside of class when appropriate. If you frequently do not come to class on time, are not prepared, and your participation detracts from the class (including unapproved cell phone and laptop use), then this will adversely affect your grade. Similarly, when you seek help during office hours, bring specific questions along with the work that you have attempted.

Academic Behavior: The overall goals of this class and of the college are for you to learn, to learn how to learn, and to pick up skills needed to be successful in life. Learning in the classroom requires an environment in which each student feels comfortable listening, thinking, concentrating, focusing, and asking questions. When you choose to attend class, you are agreeing to behave in such a way as to not disrupt the learning process of others. Otherwise, you jeopardize your enrollment in the class. So come to class prepared, interested in learning, and respectful of others. See the above paragraph on Course Participation for more guidelines on appropriate behavior in the classroom, and also in the CMU Student Code of Conduct found online.

Academic Dishonesty: Cheating is serious offense and will be treated as such. Cheating is an act of academic dishonesty, which includes using another person's work as though it was your own or knowingly permitting another student to use your work. The consequences of cheating on an assignment or quiz may result in the grade of 0 for all those involved, or in the case of an exam, an F for the course. These penalty scores are not subject to low-grade policies outlined earlier. Other situations involving cheating will be dealt with in a similar way. Further actions may be taken in accordance with the statement on academic dishonesty given in the CMU Student Code of Conduct found online.

Tutorial Learning Center (TLC) The TLC is a FREE academic service for all CMU students. Tutors are available on a walk-in basis for many courses. Located in Houston Hall 113, the TLC is open Monday - Thursday from 8am-6pm; Fridays from 8am-5pm, and Sundays from 1pm-6pm. Check out the website at www.coloradomesa.edu/tutoring or call 248-1392 with any questions.

Educational Access Services (EAS): In coordination with Educational Access Services, reasonable accommodations will be provided for qualified students with disabilities. Students must register with the EAS office to receive assistance. Please meet with the instructor the first week of class for information and/or contact Dana VandeBurgt, the Coordinator of Educational Access Services, directly by phone at 248-1801, or in person in Houston Hall, Suite 108.

General expectations for my courses:

- We will cover new material every day.
- The first few minutes of class will be devoted to answering questions from the previous class.
- If you have difficulties with the material, talk with me outside of class regarding extra help.
- Spend at least two hours each day, working on homework and studying the notes and text. Set aside this time period now in your schedule, preferably at the same time each day.
- Seek help before homework is due, and before quiz or exam.
- Ask questions – don't delay! Seek help on problems and difficulties as soon as possible. One minute of clarification right after class on a problem may save hours of frustration.
- Be persistent. Learning math sometimes requires lots of effort before a breakthrough occurs.
- Look over the book before coming to class. Sometimes 5 - 10 minutes of glancing over the text ahead of time can make a big difference in getting a handle on material presented in class.

CMU STATEMENT ON SUCCESS

The faculty and staff are glad you have elected to attend Colorado Mesa University or Western Colorado Community College and want you to succeed in achieving your academic goals. The following information is shared with you to enhance the likelihood that you will be successful.

1. Attend class.

Institutional research shows that class attendance and participation are closely linked to your success as a student (i.e., the better your attendance, the better your grade is likely to be). When you are always present, you will understand the course content and how it contributes to your growth as a college student. You are required to attend this class regularly, adhering to the attendance policy established in this course syllabus by your instructor. Additionally, you should review the Attendance Policy of the institution's **Catalog** for further details on expectations. For online courses, check with your instructor and/or class syllabus for expectations delivered in that format.

2. Prepare for and participate in class.

It takes more than showing up for class to succeed. You need to be prepared to actively participate in class. Your instructor has given you a schedule of course topics for the semester, along with readings and/or activities that should be completed prior to coming to class. If you aren't clear about these expectations, talk with your instructor. In general, you should follow the 2:1 rule: two hours of study/homework time for every 1 hour of classroom time. This can vary some from week to week, but on average, most instructors will assume you are putting in the time and keeping pace with the class. So make the effort to stay current and don't leave everything to the end of the term.

By meeting deadlines and managing your time wisely, you will get much more from the class and earn higher grades. Assume that faculty members will not accept late homework and don't offer extra credit assignments. Some may – and by reviewing the syllabus you will know their policies – but instructors have no obligation to do so. A final note. If you need help with study skills, time management, note-taking and the like, consider registering for SUPP 101, a course that helps first-year students with their transition to college life.

3. Use technology to support your success.

All members of this class are expected to show respect to each other and to contribute to a positive academic learning environment of the class. Please turn off cellphones or set them to silent when you are in class. Text messaging, checking email, working on social networking sites, and performing non-class related activities on any electronic device (cell phone, laptop, iPad, etc.) is disruptive and not acceptable behavior during the class session. Check your course syllabus for the consequence of using these devices during class time.

4. Take advantage of campus resources.

We offer numerous academic support resources to help you. The staff of **Tomlinson Library** can assist you with finding information resources either in person or online. The **Tutorial Learning Center** offers *free, walk-in* tutoring for a wide variety of subjects. Maybe it's just a math problem that's not making sense, or perhaps having a peer take a look at your assignment is what you need. The TLC can help with the smallest issue or provide you with tutoring if you have a particularly challenging course. Get help before a small problem becomes a big one. Stop by and see the services they offer, most of which are provided by other students. If your semester gets a little overwhelming, contact the **Office of Student Services** for assistance. Need to engage in some activity outside of classes? Stop by the **Maverick Center** for a good workout, or find students with some similar interests by joining a **student club**.

5. Build relationships with your instructors, advisor, and other students.

a. Your best guidance for success will come from your instructors, and research tells us that your interactions with faculty members is the most important determinate in college success. Instructors genuinely want you to be successful and will do what they can to help you reach your goals. Locate their contact information on the syllabus and store that information in your phone. Each instructor keeps office hours that they set aside to meet with students. If you cannot meet during their office hours, schedule an appointment in advance.

b. Plan to meet with your advisor at least once a semester. At a minimum, consult with your advisor on your schedule for the next semester before registration opens. Popular required courses fill quickly, so if you delay registration, you might not get your preferred courses and could possibly delay your graduation. Advisors provide valuable assistance in determining which courses you need to take for your degree and the best order to take courses. Advisors can also direct you to the most appropriate networks when you are in need of assistance.

If you do not know the name of your advisor, log into MAVzone and click on Student Academics tab. Scroll down the Academic Profile column to Advisors; directly email your advisor by clicking on envelope icon.

c. Connect with other students in all your classes. You and your peers have similar goals and will face similar challenges; this can help you feel less alone in solving problems. Being active in a study group can enrich your understanding of course materials and can provide extra motivation and support to succeed. Learn more about the value of creating a study group at *Fight for First Year in College: Form Study Groups* at http://www.academictips.org/acad/first_y_i_c/formstudygroups.html

6. Use financial aid wisely.

Be aware that your decisions about attending class and considering whether to add or drop a class can affect your financial aid. Discuss potential changes with your advisor before making them. You must complete at least 12 credit hours each semester to be considered full-time, often a requirement to receive financial aid. Part-time students should check with the **Office of Financial Aid** for credit hour requirements.Audited classes do not count for enrollment purposes.

To retain your aid for the next term, you are required to make satisfactory academic progress toward your degree and maintain the following minimum grade point averages below. **If you receive all F's for one term, you will be suspended from financial aid and must repay all Title IV funds.**

Cumulative Credit Hours Earned	**Minimum GPA**
1 to 15	1.70
16 to 30	1.80
31 to 45	1.90
46+	2.00

To remain eligible to receive financial aid, students must be successfully completing 75% of classes attempted. Aid will be suspended until the student successfully increases the completion rate to 75%. Be sure to report any changes in your enrollment, residency status, or receipt of additional resources in writing to the Office of Financial Aid. Financial aid is not available if you have not graduated from your program but exceed the total undergraduate cumulative hours as show below.

Baccalaureate degree:	170 hours
Associate degree:	80 hours
One-year certificate:	40 hours

Math 362 Introduction to Fourier Analysis I **Fall 2017 Course Calendar**

	Tuesday	Thursday
X 1	Syllabus; Course overview; 1.1 Vectors and Sampled Functions; MATLAB 22-Aug	1.2 Sound Waves and Thresholding; MATLAB 24-Aug
X 2	1.3 Image Matrices; MATLAB Class Prep 1 Due (for Week 2) 29-Aug	2.1 Functions & Signals 2.2 Sine & Cosine Functions Quiz 1 31-Aug
X 3	2.2 Sine & Cosine Functions 2.3 Complex Numbers Class Prep 2 Due (for Week 3) 5-Sep	2.4 Aliasing Quiz 2 7-Sep
X 4	3.1 Orthogonality & Similarity Class Prep 3 Due 12-Sep	3.2 Orthogonal Expansions HW 1 Due (Ch 1 & 2) Quiz 3 14-Sep
X 5	3.3 Fourier Expansions Class Prep 4 Due 19-Sep	3.4 Fourier Transforms Quiz 4 21-Sep
X 6	3.5 Time & Frequency Domain Class Prep 5 Due 26-Sep	3.6 Frequency Domain Results Quiz 5 28-Sep
X 7	3.7 Cosine Transform Type II Class Prep 6 Due 3-Oct	4.1 Vectors & Matrices Quiz 6 5-Oct
X 8	4.1 Vectors & Matrices Class Prep 7 Due 10-Oct	4.2 Orthogonal Vector Expansions HW 2 Due (Ch 3) Quiz 7 12-Oct
x 9	4.3 Discrete Fourier Transform Class Prep 8 Due (plan extra time) 17-Oct	4.4 DFT Applications Quiz 8 19-Oct
x 10	4.4 DFT Applications Class Prep 9 Due (Ch 4.5 only) 24-Oct	4.5 Spectrograms Project Ideas Due 26-Oct
X 11	4.6 DCT II Class Prep 10 Due 31-Oct	5.1 Matrix Expansions Project Selection Due 2-Nov
X 12	5.2 JPEG Compression Class Prep 11 Due 7-Nov	6.1 The CT IV Quiz 9 9-Nov
X 13	6.2 The DCT IV Class Prep 12 Due 14-Nov	Progress Reports HW 3 Due (Ch 4 & 5) 16-Nov
X 14	21-Nov	23-Nov
15	6.3 Modified DCT IV Class Prep 13 Due 28-Nov	6.4: MP3 Compression 30-Nov
16	Catch Up & Review 5-Dec	Catch Up & Review Written Project Draft Due HW 4 Due (Ch 6) 7-Dec
17	Presentations & Final Paper 12-Dec	14-Dec

MATH 362 Fourier Analysis Fall 2017 **Homework List**

The following list of homework problems is subject to changes announced in class.

Section	Long List	Short List
Ch 1.1 Vectors and Sampled Functions	1,5,7,10,12,16	5,10,16
Ch 1.2 Sound Waves and Thresholding	1,3,5,7,14,17	5,7,14
Ch 1.3 Image Matrices and Thresholding	1,5,7,9,15-17,21,22	17
Ch 2.1 Basic Properties of Signal Functions	2,3,7,10,13,17,18,20,21,23-25	10,21
Ch 2.2 Sine and Cosine Functions	1,5,11,14	5,14
Ch 2.3 Complex Numbers	2,8,13,19,22,25,34,37	2,19,37
Ch 2.4 Aliasing	1,3-7,9,12,13,15,16,23-26	1,4,12,23
Ch 3.1 Orthogonality and Similarity	2,3,5,6,15,17,37,41	5b,6b,17
Ch 3.2 Orthogonal Expansions	2,5,10,13,18,21	2,10,18
Ch 3.3 Fourier Expansions	3,8,15,20,29,33	15,20
Ch 3.4 Fourier and Inverse Fourier Transforms	1,2,5	1
Ch 3.5 Time and Frequency Domain Graphs	1,5,9,12,19,23,25,27,40,43	12,25,27,40
Ch 3.6 Frequency Domain Results	1-3,5,6,19-30,36,39	3,5,20-22,29,36
Ch 3.7 The Cosine Transform of Type II	1,2,5,9,11	2,11
Ch 4.1 Vector and Matrix Computation	1,5,9,13,19,20,29,34,45,50,58,59	20,45,59
Ch 4.2 Orthogonal Vector Expansions	1,9,17,25,29,37	29
Ch 4.3 The Discrete Fourier Transform	9,11,17,18,26,27,33,36	9,18,27,33
Ch 4.4 Basic Applications of the DFT	1,5,10,13,15,18,20,23,25,28	5c,20,25
Ch 4.5 Spectrograms	1,3,11,23,26,27	3,23,26
Ch 4.6 The DCT II	1,5,10,11,20,24,32,36	5,11,24b,d,g,36
Ch 5.1 Matrix Expansions	2-5,13,14	3,5b,c,14a,c
Ch 5.2 JPEG Compression	1,5,7,8,16,22-25	8,16
Ch 6.1 The CT IV	2,3	2
Ch 6.2 The DCT IV	1,5,10,16,20,28,32,37,43	5,20b,d,g,32
Ch 6.3 The MDCT	8,13,19	8a,b,k
Ch 6.4 MDCT Thresholding & MP3 Compression	8-10	10